

Cost reduction of Solar Cell using Modified Metallisation Pattern

Hardip Shah

Former Student, Dept. of EE, NSIT, Ahmedabad, Gujarat, India

ABSTRACT: Metallisation is a process used in manufacturing of silicon solar cells in which thick conductive inks like silver and aluminium are applied to the front and the back side of it. Silver is an important cost as well as efficiency driver in solar cell production. Generally, 3-4 busbar is printed on silicon cell to transmit generated power at optimum cost. In this experiment, screen printed busbars are redesigned. Considering slanted design as the basis, improvement in solar power collection is compared with respect to cost.

KEYWORDS: Metallisation, busbars, screen printing, solar cell.

I. INTRODUCTION

In metallisation of solar cell, metal inlines are printed on wafer with the objective to collect generated electrons. These metal inlines are printed on front and back side of the wafer which is called frontside and backside printing respectively. This is achieved by metal pastes with special screen-printing device. After each stage of printing, cell is passed through drying process where contact dried and penetrate into silicon material.

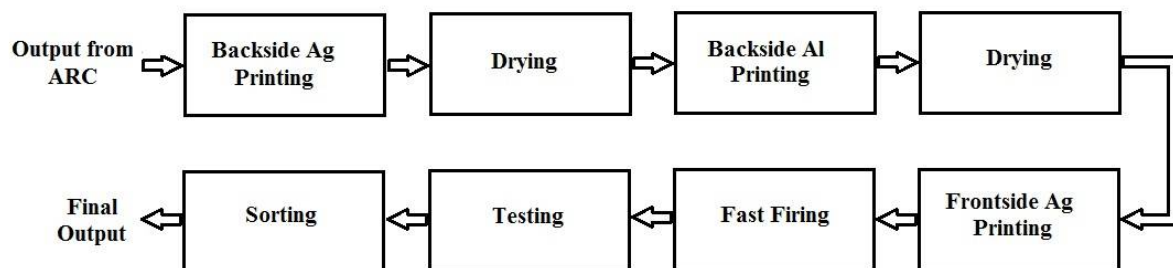


Figure 1. Metallisation process of solar cell

II. RELATED WORK

At first glance, manufacturers try to maintain elasticity of screen as well as gap between silicon cell and screen for constant and uniform paste deposition. However, it can reduce the waste of up to some extent whereas cut down solar cell manufacturing cost is crucial challenge. Redesign pattern of busbar is one of the best solutions by changing some inline backend process.

In new pattern, parameter of drying and heating process for penetration of silver contact into silicon is same as standard process whereas only screen design is changed.

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 7, Issue 9, September 2018

III.CONSTRUCTION OF STANDERD AND MODIFIED SOLAR CELL

As per standard dimension of solar cell, various parameter like use of silver, power output and contact area are discussed and compared with modified design of crossed busbar solar cell.

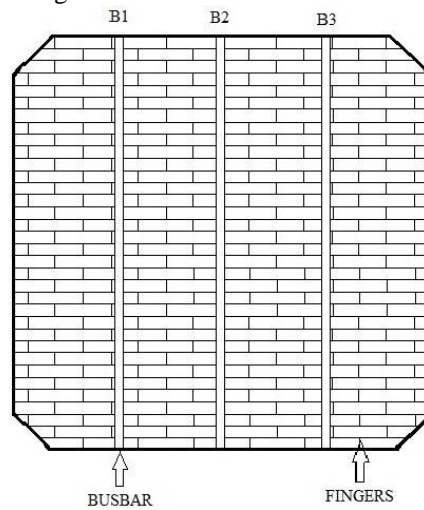


Figure 2.1. Conventional solar cell

Figure illustrate standard design of solar cell in which three busbars of similar size is used to collect electrons as form of electricity. In below table dimension of standard solar cell in written after benchmarking process.

Sr No.	Parameter	Dimension
1	Size of cell	156mm*156mm
2	Number of busbars	3-4
3	Number of fingers	76*4=304
4	Length of busbar (B1=B2=B3)	156*3=468mm
5	Width of busbar	2-2.5mm

Table1. Dimension of standard solar cell

IV.METALLISATION AS PER DESIGN

Modified solar cell with crossed busbar is designed and printed which provide more contact area and require less silver compare to standard one. Extra contact area on the surface of silicon gives extra power output and uplift efficiency. In addition, less silver proves crucial cost reduction factor whereas overall manufacturing cost is reduced. This design can apply on both side of solar cell.

Modified design of metallisation is shown in below figure that depicts crossed printed busbar at 45 to reduce the length of it compare to standard one.

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 7, Issue 9, September 2018

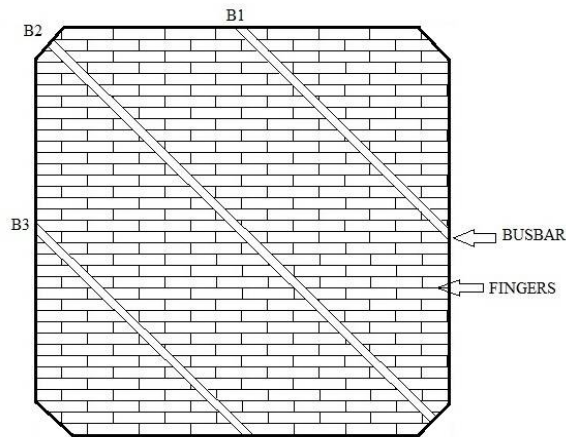


Figure 2.2. Modified solar cell

V. WORKING AS PER DESIGN

In standard type of solar cell, flow of electron is directly dependent on radiation of sun light. However, collection of this electron draws high amount of energy which is an area of conflict. High amount of energy being waste here. Metallisation of cell is most important and efficiency deciding process. In this process, metal like silver and aluminium is printed with help of screen, squeeze and other equipment.

Dryer is used in between every stage in which deposited metal is penetrated in to silicon and provide better contact. At last, cell is heated in fast firing section where temperature is up to 750-800 C.

Process of modified design solar cell is same as standard one. However, different type of screen is required that print crossed busbar on cell.

VI.METHODOLOGY

At first, total length of busbar and silver paste deposition is calculated. Simultaneously, cost reduction is compared with ordinary one.

Total length of busbar (standard metallisation):

$$\begin{aligned} &= B1+B2+B3 \\ &= 156*3 \text{ mm} \\ &= 468 \text{ mm} \end{aligned}$$

Total length of busbar (modified metallisation):

$$B2^2 = (156)^2 + (156)^2$$

$$\text{So, } B2 = 220.61 \text{ mm}$$

Similarly,

$$B1=B3=0.5B2$$

$$\text{So, } B1=B3=110.3 \text{ mm}$$

$$\begin{aligned} \text{Total length} &= B1+B2+B3 \\ &= 441.2 \text{ mm} \end{aligned}$$

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 7, Issue 9, September 2018

Paste deposition on solar cell:

Average paste deposition according to manufacturer's = 2.45-2.55 gm

So, Reduction in paste deposition = 14-16 mg

Comparison of silver paste deposition w.r.t length

$$\frac{\text{Total length of busbar (Modified metallisation)}}{\text{Total length of busbar (Standard metallisation)}} \times 100$$

= 94.27%

It means 5.73% of silver can save each side using this method. However, 80-85% of cost is used while manufacturing of solar cell. Overall, it reduces 8-10% cost.

VII. ADVANTAGES

- Less fingers and busbars consume less amount of silver which plunge cost ultimately
- High area covered because of crossed angled busbar which augment overall efficiency
- Solar cell will be more efficient after laser opening process as contact will be penetrated deeply.
- It saves silver. As source of silver is limited and research of its alternative are still in progress. So, it is indispensable to save it.

VIII. LIMITATION

- New design of screen is required which require one-time investment.
- As there is crossed angled busbar, design of cell tester needs to change.

IX. CONCLUSION

After making this design and calculating the usage of silver, it is concluded that, modified metallisation process reduces manufacturing cost and saves resources. However, one-time investment for changing the line process proves economical after serval time.

REFERENCES

1. W. E. Taylor, N. Mardesich, C. F. Gay "The Impact of Screen Printing on the Cost of Solar Cell Metallization", J sol. Energy Eng., Vol.102, pp 55-58, 2009
2. Attequr Rehman, Soo Hong Lee, "Crystalline Silicon Solar Cells with Nickel/Copper Contacts" Open access peer reviewed chapter, 2015
3. Apoorva Srinivasa, "Front Grid Metallization of Silicon Solar Cells", A Thesis Presented in Partial Fulfillment of the Requirements for the Degree Master of Science, December 2015
4. P. Papeta, L. Andreettaa, D. Lachenala, G. Wahlia, J. Meixenbergera, B. Legradica, W. Frammelsbergera, D. Bätznera, B. Strahma, Y. Yaob, T. Söderströmb, "New cell metallization patterns for heterojunction solar cells interconnected by the Smart Wire Connection Technology", Presented in 5th Workshop on Metallization for Crystalline Silicon Solar Cells
5. A. R. Burgers, "How to Design Optimal Metallization Patterns for Solar Cells", Netherlands Energy Research Foundation, 1999
6. J.A. Rand, "Solar Cell Design for Manufacturing", Final report of National Renewable Energy Laboratory, 2005-07
7. Chetan Singh Solanki, "Solar Photovoltaic Technology and Systems-A manual for technician trainers and engineers", PHI Learning Pvt Ltd., vol.61, 2013
8. QiquanQiao "Organic Solar Cells: Materials, Devices, Interfaces, and Modeling" CRC Press, 1 edition, 2015
9. Gavin Conibeer, Arthur Willoughby "Solar Cell Materials: Developing Technologies", John Wiley & Sons, Ltd, 2014
10. Stephen Fonash "Introduction to Light Trapping in Solar Cell and Photo-detector Devices" Academic Press 2014
11. Augustin Joseph McEvoy, Luis Castañer, T. Markvart "Solar Cells: Materials, Manufacture and Operation" Academic Press, 2012
12. Antonio Luque, Steven Hegedus "Handbook of Photovoltaic Science and Engineering, Second Edition", John Wiley & Sons, Ltd, Second edition, 2011
13. Rauschenbach, Hans S., "Solar Cell Array Design Handbook", Springer Netherlands, 1980